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"Sustainability and efficiency in urban mobility: an international comparison"

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Abstract

After an initial introduction concerning generic sustainability and its various definitions, I explain the sustainable mobility and its characteristics, why it's important and the different approaches to achieve it. Next I will focus on urban mobility and I'll describe twenty actions to improve it, published by the Commission of European Communities in 2009, covering topics like sustainable urban mobility plan, the relation between attitudes of people and their travel behavior, lower and zero emission vehicles, urban freight transport policies and the CIVITAS Initiative. Then I'll present land use planning as a solution to excessive extension of infrastructures and urban sprawl, and I'll describe also the concept of “traffic evaporation”.

For the experimental part, I compared the urban mobility of eight European cities measuring the average trip time between three main attractors within each city, with private car and public transport, and the average cost of every trip. I conclude the thesis showing the relative competitiveness of the public transport and finding out if (and how much) the cities that took part in the CIVITAS project have a better urban mobility than the others.

Introduction

In the last three decades Sustainability has become one of the most important topics in almost every discipline. In this thesis we will discuss about one of the least sustainable human activities: the mobility.

In the 2010 the greenhouse gas emissions originated from fuel combustion in transport accounted for the 19.7% of the total in the EU-27 (only the emissions from fuel combustion of energy industries accounted for more), with an increase of 20% in the last 20 years (Eurostat, 2012); in the USA the situation is even worse, with the transportation representing the 27% of total greenhouse gas emission; in particular road transport, accounting for eight tenth of that percentage (EPA, 2012). It's clear that the tendency of the private-car mobility to increase is unbearable and must be slowed down.

Prior to discuss the concept of sustainable mobility we need to shed light on the original concept of sustainable development. The 1987 report "Our Common Future" of the United Nations has become the reference point for its definition, which is deeply analyzed in the book "Achieving Sustainable Mobility" by its author Erling Holden (2007). The Norwegian author (inspired by a paper of another Norwegian professor, Høyer (2000)) divides the characteristics of sustainable development in three levels: extra prima, prima and secunda. They are in a hierarchical order and the extra prima characteristics (that therefore have precedence over the others) are:

I. Safeguarding long-term ecological sustainability;
II. Satisfying basic needs;
III. Promoting inter and intra-generational equity.

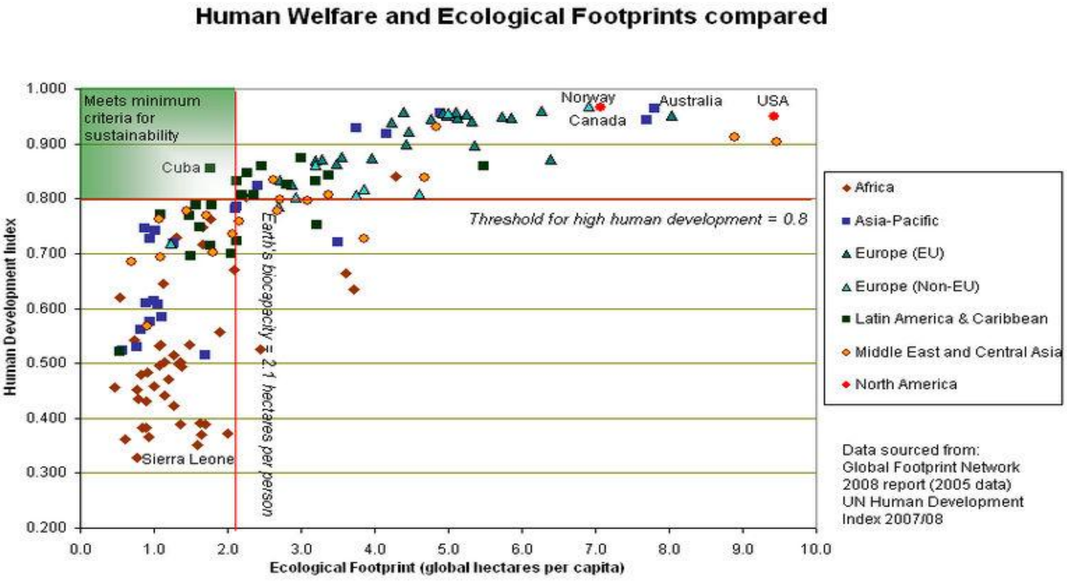
The ecological sustainability must be obtained because otherwise the loss of plant or animal species can greatly limit the possibilities of future generations to reach their basic needs, and moreover "It is part of our moral obligation to other living beings and future generations' (United Nations, 1987, p. 57). About the basic needs the Burtland report (as the

United Nations report is known) cites employment, food, energy, housing, water supply, sanitation and health care; while the last prima characteristic implies that the present generation must meet its needs without compromising the ability of future generations to meet theirs and even that social equity between generations must be extended to equity within each generation (Holden, 2007).

There are other distinctions that can be made inside the sustainability concept, for example Holden (2007) resumes Turner's recognition (1993) of four different types of sustainability: very weak, weak, strong and very strong. The first one impose that the overall stock of capital assets should remain constant over time, so it's possible the reduction of any asset (even natural capital) as long as another one is increased to compensate for such a reduction. The weak one imposes just some degree of restriction on the economic activities but there is still a high degree of replaceability between all forms of capital resources. Strong sustainability claims that natural capital needs a specific protection since some critical parts of it cannot be replaced by other forms of capital; finally the very strong definition sustain that no forms of natural capital are substitutable and therefore the human development faces great limits.

A well-known and concise measure for the sustainability of a country is the ecological footprint, developed by William Rees and Mathis Wackernagel in the 1996 as an elaboration of the “carrying capacity” concept: it is a standardized measure of the natural capital that a human population consumes. Thus, a population's ecological footprint is the total area required to produce everything that it consumes, assimilate its waste and give space for its infrastructure (Holden, 2007). Nowadays the long-term ecological sustainability is not reached at all since the global population's ecological footprint exceeds the Earth's biological productive area, even if with huge differences between countries, as we can see in the following chart (Figure 1).

Figure 1



The ecological footprint of every country has been related to its human development index (a composite statistic of life expectancy, education, and income indices), and just one of them is inside the area which meets the minimum criteria for sustainability (but other sources, like World Centric put Earth's bio-capacity even lower, at 1,9 hectares per person).

Sustainable mobility

After having remarked the importance of sustainability in general, now we focus on the concept of sustainable mobility. The concept of "sustainable mobility" increased its importance since the "Green Paper on the Impact of Transport on the Environment" by the European commission (1992) with the purpose of integrating sustainable development principles into various EU policies, and since then a large and rich literature on this field has been created. In these years the perception of the concept has evolved, as explained by Holden (2007): whereas most studies of sustainable mobility in the early 90's focused exclusively on transport's environmental impacts, later studies also focused on social and economical impacts.

There were also changes in the EU policy focus dimension: while the emphasis in the 1992 EU Green Paper was on reduction of transport volume, in the 2001 EU White Paper on European Transport Policy there was a shift towards the need of a reduction in transport intensity and congestion.

Following the approach of Holden (2007), we can highlight the three extra prima characteristics of sustainable mobility, derived directly from those of the sustainable development:

I. Impacts of transport activities must not threaten long-term ecological sustainability;
II. Basic mobility needs to be satisfied;
III. Inter and intra-generational mobility equity must be promoted.

And to reach these targets the developed countries should halve their energy consumption for passenger transport (as suggested also in the low-energy scenario in Burtland report, p.121) and increase mobility for the low-mobility groups.

There are basically three approaches explored by the literature that can lead to sustainable mobility, here as presented by Holden (2007):

I. The efficiency approach, it suggests that the environmental problems caused by transport and the lack of accessibility for low-mobility groups can be solved just by developing more efficient technology. The efficiency approach can be divided into two main sub-approaches:

   a) the use of new, conventional technology (e.g. improvements in existing engines or fuels);
   b) the use of alternative technology (e.g. new drive systems).

II. The alteration approach, it imposes the change of present transport patterns, dominated by private cars and planes, for going towards a future of reliable and affordable public transport system. This approach comprises also the idea of increasing walking and cycling, even if there is a danger that improved public transport could lead to less walking and cycling because cyclists and pedestrians might find public transport more attractive;

III. The reduction approach: according to this one, the reductions of the two previous approaches are not large enough to meet sustainable mobility's energy goal, even because continuous transport growth negates any reductions in energy consumption achieved by implementing new technology and altering transport patterns. Thus, present transport volume must urgently be decreased (except for those whose basic transport needs are not met).

Must be noted that substantial grey areas exist between the approaches, so in various practical policy they will likely overlap, and it could be seen as a strength if a sustainable mobility policy could combine elements from the three approaches.

According to Banister (2007) the purpose of sustainable mobility is allow both high-quality accessibility and a high-quality environment, the intention thus is “not to prohibit the use of the car, as this would be both difficult to achieve and it would be seen as being against notions of freedom and choice. The intention is to design cities of such quality and at a suitable scale that people would not need to have a car.”

To accomplish this target, the sustainable mobility paradigm must question two hypothesis that are no more true even if have been the starting point of transport planning for many years. The first states that travel is a derived demand and not an activity that people wish to undertake for its own sake: it is only the value of the activity at the destination that results in travel. This can be true unless incomes rise and leisure time becomes more valuable, because in this case escape theory (Heinze, 2000) hypotheses that leisure mobility is an attempt to compensate for a declining quality of life, and travel opportunities are used to do something completely different and to get away from ones everyday environment. This implies that a remarkable amount of leisure travel is undertaken for its own sake and the activity of traveling is valued.

The second hypothesis is that people minimize their generalized costs of travel, using as a variable the financial cost of travel and the time taken. There is an evident inconsistency since in more and more cities much effort is now going into slowing traffic down for environmental and safety reasons. In many urban areas new low speed limits have been introduced and a new key policy objective now becomes that of reasonable travel time, thus is the reliability of the system that is crucial rather than travel time minimization. The main interest of people can shift to simply know, with a reasonable degree of certainty, how much their travel will last, with less concern about the speed (Banister, 2007).

A key factor in achieving sustainable mobility is involving people, indeed even with a great public transport there will always be an additional reason for still using the car; moreover the automobile manufacturers are used to sell the symbolism and seductiveness of the car (Cass et al., 2005). The use of “push and pull” measures (OECD, 2004) can increase people's opportunities while, at the same time, regulate people's behavior in such a way that their options and freedom to move are restricted to some extent. “Push” measures tries to charge transport users with a greater proportion of the real costs of their journeys, including costs of pollution, accidents and infrastructure. They can be divided into financial instruments (e.g. higher fuel taxes, car parking charges) and technical and regulatory constraints (e.g. traffic orders, removal of parking space and ban of vehicles). On the other side, “pull” measures are designed to encourage less use of the car by making alternatives more attractive. These measures include a better coordination of buses, trams, underground and rail systems and also proper integration with transport planning. This kind of measures generally increase people's opportunities and individual freedom of choice. But, on their own, “pull” measures alone are not always sufficient to effect a change in transport patterns and a mix of “push” and “pull” measures is, therefore, often needed, since policy combination produces usually better results than the sum of the individual policies applied alone.

Obviously “pull” measures tend to be popular while many people are reluctant to give up the perceived freedom associated with owning and using private car, and thus “push” policies tend to be unpopular (Transport, Health and Environment Pan-European Programme).

To reach popular consensus, a policy package must be seen as fair, inclusive of all the society and with a high possibility of success; for this reasons some countries in the EU now relate the annual taxation for vehicles to their pollution profile. For example in Germany electric vehicles are exempt from the annual circulation tax for a period of five years from the date of their first registration, in Belgium purchasers of electric cars receive a personal income tax reduction of 30% of the purchase price (ACEA, 2010), and in the UK annual vehicle taxation is related to the CO_2 emissions figures, with six different tax rates (Driver and vehicle licensing agency, 2012).

It is not only important to bring the information in itself to the final user, but it is also important the way such information is organized and communicated, therefore an active involvement of the customer is essential. The legitimacy of policy measures must be based on a participatory and inclusive approach that involves "selling" the message of sustainable mobility to individuals, groups and localities through explaining the need for changes in behavior and convincing them of the importance of their contribution (Banister, 2007).

The Commission of the European communities in its 2001 White Paper asserted that "as demand for transport keeps increasing, the Community's answer cannot be just to build new infrastructure and open up markets. The transport system needs to be optimized to meet the demands of enlargement and sustainable development" (p.10). The main problems in the pattern of European mobility were recognized in the unequal growth in the different modes of transport and in the price structure that generally fails to reflect all the costs of infrastructure, congestion, environmental damage and accidents that a transport user generates. Therefore the ideal strategy was a modal shift in order to "break gradually the link between transport growth and economic growth.

Unfortunately this vision was modified in the 2011 white paper, where the main challenge became to "break the transport system's dependence on oil without sacrificing its efficiency and compromising mobility" (p. 5), curbing mobility was no more an option (mainly because transport industry in the EU directly employs around 10 million people and accounts for about 5% of GDP) and all the hopes for a more sustainable future have been directed to new and more efficient vehicles.

Nevertheless EU is deeply aware of the environmental problem related to greenhouse gas emissions, with a required reduction in the transport sector of at least 60% of GHGs by 2050 with respect to 1990 level. By 2030 the goal for transport will be to reduce GHG emissions to around 20% below their 2008 level, but given the substantial increase in transport emissions over the past two decades, this would still put them 8% above the 1990 level (European Commission, 2011).

The transport system therefore is still not sustainable, even if since the

2001 White Paper on Transport, a lot has been achieved like further market opening in aviation, road and partly in rail transport, the Single European Sky has been successfully launched, the safety and security of transport across all modes has increased, new rules on working conditions and on passenger rights have been adopted, international ties and cooperation have been strengthened etc. (European Commission, 2011).

An increasing majority of the European citizens are requesting changes to promote modes of transport which are more respectful of their environment. A survey commissioned by the Directorate-General for the Environment revealed that 89% of Europeans surveyed in 2002 were concerned about future trends in the field of environment and health, and they quoted car traffic problems as the main reason for their discontent, as far as the environment in which they lived was concerned (Directorate-General for the Environment, 2004).

Favoring more sustainable transport modes can also promotes accessibility and social inclusion for all those people which have no access to a private car, due to monetary limit.

Urban mobility

One of the key issues of sustainable mobility is the urban mobility: since in 2007 72% of the European population lived in urban areas, cities face more than any other area the challenge of making transport sustainable in environmental and competitiveness terms while at the same time addressing social concerns (Commission of the European communities, 2009).

The 2011 White Paper notes that “In cities, switching to cleaner transport is facilitated by the lower requirements for vehicle range and higher population density; public transport choices are more widely available, as well as the option of walking and cycling.” Although, “cities suffer most from congestion, poor air quality and noise exposure. Urban transport is responsible for about a quarter of CO_2 emissions from transport, and 69% of road accidents occur in cities”.

Moreover urban mobility is also a central component of long distance transport because most of it starts and ends in urban areas so cities should provide efficient interconnection points for the trans-European transport network and offer efficient “last mile” transport for both freight and passengers.

In this chapter I present a plan with twenty actions to improve the urban mobility, edited by the Commission of European Communities in 2009 centered on six themes that emerged from the debate that followed the publication of the Green Paper on Urban Mobility (2007), pointing out a coherent framework for EU initiatives in the area of urban mobility while respecting the principle of subsidiarity.

The document, “Action Plan on urban mobility”, starts off noting that “nine out of ten EU citizens believe that the traffic situation in their area should be improved. The choices that people make in the way they travel will affect not only future urban development but also the economic well-being of citizens and companies” (p.2), so the first theme is “Promoting integrated policies” since an integrated approach can best deal with the complexity of urban transport systems, the links between cities and their surrounding areas and the interdependence between transport modes. This theme will handle also the topic of sustainable urban mobility plan, the plan-financing with the Structural and Cohesion Funds and the relation between traffic-related air pollution and healthy urban environments.

The second theme is about the final users of the public transport: the citizens, focusing on their rights (especially for those with reduced mobility), providing them: information about the travel; education for a sustainable driving behavior and a complete awareness on sustainable mobility (and I'll present a study by Holden that analyze the effectiveness of such campaigns, relating attitudes of people with their travel behavior).

The third theme concerns the importance of making urban transport more eco-friendly, therefore covering the topic of lower and zero emission vehicles (achievable with technological innovation in different ways), the possible consequence of rebound effects, the internalization of external costs with market-based incentives and their related pricing schemes.

The next theme is about the need of investment: optimizing existing funding sources and analyzing the future needs, with the support of ex-ante project evaluation criteria and private public partnership (PPP); moreover I'll briefly describe the CIVITAS Initiative.

The fifth theme concerns the experience and knowledge learned by the policy-makers that must be shared, both at national and local level (for example what happens in the European NICHES+ Project), upgrading data and statistics available and creating an urban mobility observatory.

The last theme is about optimizing urban mobility, improving interoperability and interconnection between different transport networks (including urban freight transport policies for reducing problems derived by the delivery of goods in urban areas), facing the pollution and congestion deriving from commuting to work and finally creating an Intelligent transport systems (ITS).

Going now into detail, the first theme is “Promoting integrated policies” because transports are linked also with environment protection, land use planning and social aspects of accessibility and mobility, and even policy making will benefit from an integrated approach.

The first action suggested is to accelerate the take-up of sustainable urban mobility plans. The Commission will support local authorities providing guidance material, promoting best practice exchange, identifying benchmarks and supporting educational activities for urban mobility professionals. Whenever possible, the Commission will also encourage Member States to provide platforms for mutual learning and sharing of experiences and best practices that would foster the development of sustainable urban mobility policies (CEC, 2009). The Urban Mobility Plan is defined in another document by Bührmann, Wefering and Rupprecht supported by the Intelligent Energy Europe program (“Guidelines: developing and implementing a sustainable mobility plan”, 2011): a Sustainable Urban Mobility Plan is “a strategic plan designed to satisfy the mobility needs of people and businesses in cities and their surroundings for a better quality of life. It builds on existing planning practices and takes due consideration of integration, participation, and evaluation principles” (p.6).

Its definition is quite generic since it has many objectives: it should ensure that accessibility offered by the transport system is available to all, improve safety and security, improve the efficiency and cost-effectiveness of the transportation of persons and goods and contribute to enhancing the attractiveness and quality of the urban environment and urban design. To reach these ambitious objectives all the stakeholders must be involved, from the outset and throughout the process in decision making, implementation and evaluation. There is a large variety of benefits associated with sustainable urban mobility planning, besides the primary targets: environmental and health benefits, closely related to the positive environmental effects and improvements in terms of air quality and noise; perception of a city improved, projecting the image of being innovative and forward-looking; new political vision, providing a longer term agenda and a clear program to work towards; improving a city's competitiveness and access to funding, since there are certain funding pools that are available for innovative solutions or integrated planning approaches (Intelligent Energy Europe, 2011).

The second action proposed is indeed on the sustainable urban mobility and regional policy that can be financed with the Structural and Cohesion Funds and the European Investment Bank. The Commission will increase awareness of the funding available, list funding opportunities and explain the application of State aid and public procurement rules.

The third action is directed to create a transport system compatible with a healthy urban environment. The Commission will explore the implementation of the strategies on nutrition, overweight and obesity, environment and health, injury prevention and cancer, further synergies between public health and transport policy.

A health impact study of traffic related air pollution in three European countries (Austria, France and Switzerland) found air pollution to be responsible for 6% of total mortality or more than 40.000 cases per year, about half of which was attributable to motorized traffic. Transport also accounted for more than 25.000 new cases of chronic bronchitis in adults, more than 290.000 episodes of bronchitis in children, more than 0,5 million asthma attacks and more than 16 million person-days of restricted activities (Künzli, Kaiser et al., 2000). Thus, although individual health risks of air pollution are relatively small, the public-health consequences are considerable and sustainable urban transport can play a role in creating a healthy environments.

The second theme concerns the focus on citizens. European Commission claims that high quality and affordable public transport is the backbone of a sustainable urban transport system. Reliability, information, safety and ease of access are vital, and community participates with a legislation that already regulates large parts of public transport investment and operations.

On this theme the first action is the creation of a platform on passenger rights in urban public transport. The Commission will moderate a dialogue with stakeholders in order to identify best practices and conditions for strengthening passenger rights in urban public transport.

The aim is to develop a uniform interpretation of EU Law on passenger rights and a harmonized and effective enforcement, to ensure both a level playing field for the industry and a European standard of protection for the citizens. For doing this is important to assemble common principles applicable to passengers' rights in all transport modes and consequently consider the adoption of a single EU framework regulation covering passenger rights for all modes of transports.

The action could be completed with a set of ambitious voluntary commitments in place, for example quality indicators as well as commonly agreed complaint procedures.

The fifth action is about the accessibility for persons with reduced mobility, since access for them is often insufficient and sometimes non-existent.

Considerable achievements have been made, for example on the use of low platform buses, but other modes of public transport such as subways remain often largely inaccessible (CEC, 2009).

A commitment in this sense was the signing in 2007 by the European Community and all Member States of The United Nations Convention on the Rights of Persons with Disabilities. In the article 9 it states that "parties shall take appropriate measures to ensure to persons with disabilities access, on an equal basis with others, to (…) transportation, both in urban and in rural areas".

Sixth action: improving travel information. Travel information must be supplied to citizens through different media, even with a legislative proposal to ensure access of private service providers to travel and real time traffic information. Commission will also support the development of national and regional multi-modal journey planners with the ultimate aim of providing users with a public transport travel portal at EU level on the internet.

The following action is about the access to green zones while the eighth is pretty open to debate, and it concerns campaigns on sustainable mobility behavior, directed to increase awareness on the problem of urban mobility and create responsible attitudes. No strategy could be adopted without a direct and committed participation of consumers, since regulation without prior popular support might be counterproductive in the long term (Holden, 2007); already in Agenda 21, the action plan from the 1992 UNCED meeting in Rio de Janeiro, was remarked that “governments and private sector organizations should promote more positive attitudes towards sustainable consumption through education, public awareness programmes and other means" (p.22). In Holden (2007) there is a study relating attitudes of people with their travel behavior in everyday travel, in long distance leisure time travel by car and by plane. The project was based on a household survey in the Greater Oslo Region.

First of all it must be clarified that the term “attitude” is defined as a predisposition to behave in a certain way, and a large number of empirical studies made it already clear that orally expressed attitudes do not usually correlate highly with overt behavior (Ronis et al. 1989).

Holden (2007) cites another paper by Thøgersen (1999) in which are presented the three main consequences (in the topic of environmentally responsible consumption) of a weak correlation between attitudes and behavior: it could reduce the usefulness of attitude research in the environmental field, it reduces the producer's faith in the economic defensibility of developing environmentally friendlier products and it reduces the effectiveness of political interventions.

Of course failure to find attitude-behavior consistency can be also due to the fact that attitude is only one of the factors that influence behavior.

Returning to Holden's survey, the questionnaires were sent during March and April 2003 to 2.500 randomly selected individuals above the age of

17. An average of 120 respondents per area answered the questionnaires, a rate of 40 per cent. The questions concerned the individual's and the household‘s consumption of energy and transport, as well as family structure, income and housing facilities. Both bivariate correlation analysis and multiple regression analysis were applied.

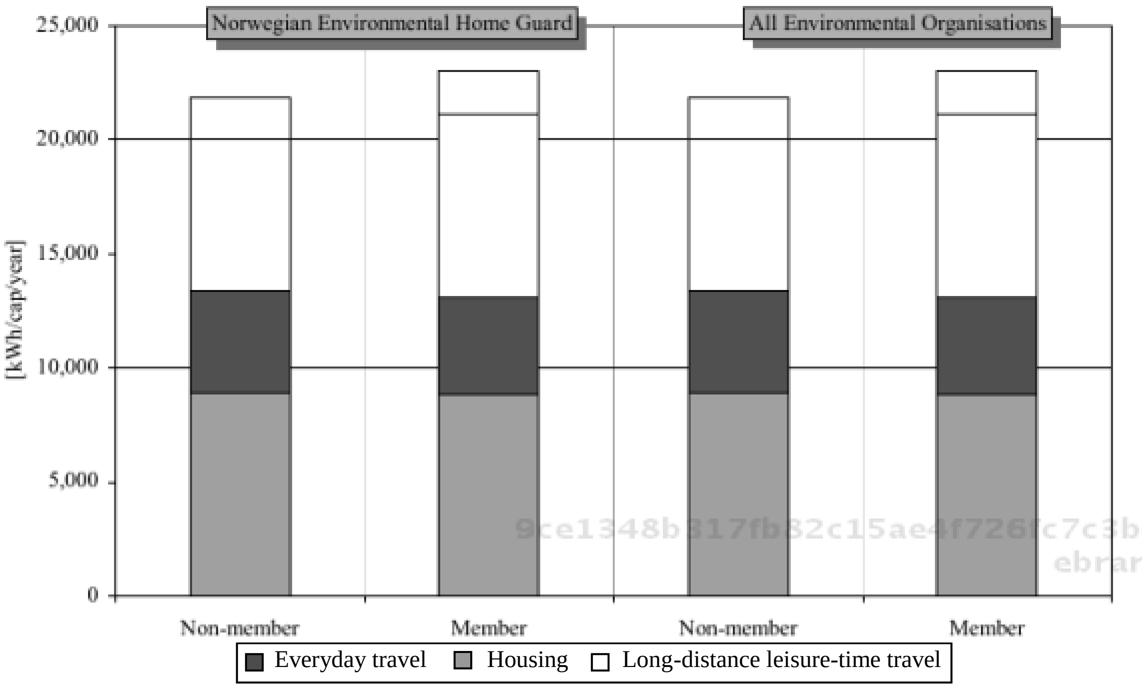
The attitude of a person is really hard to observe or measure; in this case four attitude levels were identified. At the highest level, membership in NEHG has been used as a measurement of attitude.

The Norwegian Environmental Home Guard is the oldest environment organization in Norway (created in 1991) and is also the major green consumer's network in the country. Members of the NEHG are assumed to have highly positive attitudes towards environmental issues both in general and related to specific consumption practices.

At the second attitude level have been put the respondents that were members in an environmental organization other than the NEHG. The third and fourth attitude levels were analyzed using a Likert Scale whereby attitudes are measured according to whether a respondent expresses agreement or disagreement with statements on household consumption.

As we can see from the Figure 2, among the four groups the difference in average yearly energy consumption per household member is not large. The high-energy group consumes only five per cent more energy than does the low-energy group. Surprisingly, members of an environmental organization (NEHG or other) have higher total energy consumption than non-members.

Figure 2



The results are confirmed by the bivariate analyses, underlining that there are only small differences between the total household consumption of green individuals and that of ordinary individuals, and to the extent that there are differences, they do not favor the green individuals.

More in deep, green individuals are more environmentally responsible in their everyday lives than ordinary ones, but they nevertheless cast aside their environmental concerns when traveling for leisure.

Holden tries to explain the discrepancies between what individuals intend to do and what they actually do with “the force of habit”, since when behavior becomes habitual, it is relatively autonomous and therefore independent of attitudes and beliefs. Thus, attitude change can occur without a corresponding change in behavior, leading to attitude-behavior inconsistency.

Then the attention is turned to a series of in-depth interviews conducted by the author in 1999 with households in Greater Oslo and Forde (Holden 2001). From this qualitative study has emerged that everyone has a domain where they relax, where they do not submit to their own convictions and attitudes and in which they do not feel that they have to do something in order to project a particular image, but when they act in this domain they do so because they want to.

The green respondents are not at all proud of this type of behavior, indeed they do not wish to be identified with this type of consumption, and would prefer that it remains a secret. Anyway this difference between attitude and behavior needs more studies and researches to find out if creating a green attitude among the citizens could be a useful tool for the policy maker or can be ignored.

The last action for the second theme is the energy-efficient driving as a part of driving education.

Energy-efficient driving is already a mandatory part of the training and testing of professional drivers, and the Commission should discuss with Member States about the option of including it also in driving tests for private drivers.

The third theme concerns the greening urban transport, and many environmentally friendly policies have been introduced in various cities across the EU. The first action of this theme is about the research and demonstration projects for lower and zero emission vehicles. Action at EU level, like the Seventh Framework Programme for research and technological development (FP7) can help to strengthen markets for new, clean vehicle technologies and alternative fuels, aiming to reduce dependency on fossil fuels.

Also in the White Paper (2011) there is a large section on the importance of phasing out conventionally-fuelled vehicles from the urban environment, because is a major contribution to significant reduction of oil dependence, greenhouse gas emissions and local air and noise pollution.

Is also noted that the race for sustainable mobility is a global one, and delayed action or timid introduction of new technologies could condemn the EU transport industry to irreversible decline, so it's a very important topic in which are needed immediate actions; it's also for this reason that halving the use of conventionally-fuelled cars in urban transport by 2030 and phase them out in cities by 2050 is the first of ten goals for achieving the 60% GHG emission reduction target by 2050, presented in the White Paper (2011).

The widespread use of lower and zero emission vehicles will have to be complemented by the development of appropriate fueling and charging infrastructure.

The White Paper (2011) makes clear that more resource-efficient vehicles and cleaner fuels are unlikely to achieve on their own the necessary cuts in emissions, and they would not solve the problem of congestion. They need to be accompanied by the consolidation of large volumes for transfers over long distances. This implies greater use of buses and coaches, rail and air transport for passengers and, for freight, multi-modal solutions relying on waterborne and rail modes for long-hauls. It's also fundamental be aware that there may be some rebound effects: the behavioral response to a new technology that increase the efficiency could be an increase in consumption or use that counterbalances the beneficial effects. For example people may drive more because the vehicles are more efficient or more efficient engines put into larger, faster and more comfortable cars may be unable to reduce energy consumption.

Moreover, eliminate the necessity of oil in the transports will not be possible relying on a single technological solution. It requires a new concept of mobility, supported by a cluster of new technologies as well as more sustainable behavior. Technological innovation can achieve a faster and cheaper transition to a more efficient and sustainable European transport system by acting on three main factors:

I. Vehicles' efficiency through new engines, materials and design;
II. cleaner energy use through new fuels and propulsion systems;
III. better use of network and safer and more secure operations through information and communication systems (White Paper, 2011, p.12).

Consumers need support towards new clean and energy-efficient vehicles, with an overview of legislation and all the possibilities provided by the market, and this is the aim of the eleventh action suggested by the European commission: an internet guide to help the citizens and provide support for the joint procurement of vehicles for public services. This service will also facilitate the implementation of the new Directive on clean and energy-efficient vehicles.

Action number twelve concerns the importance of the urban aspects of the internalization of external costs: the intention of the Commission is to launch a methodological study on the urban aspects of the internalization, looking at the effectiveness and efficiency of various pricing solutions

This must include a clear analysis of all the issues related, such as public acceptability, social consequences, cost recovery, availability of ITS (intelligent transport systems) tools and how urban pricing policies and other green zone arrangements can be effectively combined.

To increase the efficiency of transport is also suggested in the White Paper (2011) to use market-based incentives. Indeed "price signals play a crucial role in many decisions that have long-lasting effects on the transport system. Transport charges and taxes must be restructured in the direction of wider application of the "polluter-pays" and "user-pays principle", since the overall burden for the sector should reflect the total costs of transport including infrastructure and external costs (p.16).

The internalization of externalities is therefore part of the effort to align market choices with sustainability needs (and to reflect the economic costs of non-sustainability); this is easier to implement in the urban area with tools like parking fees, congestion charging and management of urban transport prices. All these measures are necessary to establish a level playing field between ways of mobility which are in direct competition, but in different levels of sustainability.

The next action is directly related, since it's about the role of the Commission on facilitating information exchange among experts and policy-makers on urban pricing schemes in the EU, using input from existing initiatives and including information on consultation processes, scheme design, information provision to citizens, operating costs and revenues and the impact on the environment.

The fourth theme is about the strengthening funding: all the important actions to reach sustainable urban mobility need investment (infrastructure, vehicles, new technologies, improved services and much more). Expenses can be covered by local, regional or national sources. Local sources can include local taxes, passenger transport charges, parking fees, green zone charges and urban pricing, and private funding. The growing needs for funding complex transport systems and the evident decrease in the availability of public financing are the main challenges for the future. The use of EU funding, including European Investment Bank instruments, can provide significant incentives and help leverage private funds. In the short term, the Commission can help authorities and stakeholders to explore existing funding opportunities and develop innovative public-private partnership schemes.

Related to this topic, could be useful introduce ex-ante project evaluation criteria making certain that every infrastructure project bring some added value to sustainable mobility, and then introduce Private public partnership screening to the ex-ante evaluation process to ensure that the option of PPP has been carefully analyzed before a request for EU funding is being asked (White Paper, 2011).

Optimizing existing funding sources is the first action of this topic. The Structural and Cohesion Funds, with over 13 billion euros allocated to transport sector during the period 2000-2006, are a very important funding source for investment in infrastructure for the weakest EU countries (Steer Davies Gleave, 2009). Under the "Transport theme" of the seventh Framework Programme there is also a priority area dedicated to sustainable urban mobility in which the European Commission declares as a target “Ensuring sustainable urban mobility for all citizens including the disadvantaged: innovative organization schemes, including clean and safe vehicles and means of transport with lower levels of pollution, new high quality public transportation modes and rationalization of private transport, communication infrastructure, integrated town planning and transport taking into account their relationship with growth and employment" (European Commission, 2006). Only in 2013 around 365 million euros will be invested to support innovation in energy, transport and information and communication technologies (ICT) to transform urban areas into smart, sustainable, low-carbon environments that are resilient to the impacts of climate change (European Commission, 2012). Finally, funding has been allocated to urban mobility actions in priority areas of the Green Paper on urban mobility, following a call for proposals launched in 2008.

Action fifteenth is about analyzing the needs for future funding. The Commission will continue to financially support the CIVITAS Initiative beyond the third generation of projects that started in 2008. As stated in its official website, the CIVITAS Initiative ("City-Vitality-Sustainability", or "Cleaner and Better Transport in Cities") is co-financed by the European Union and was launched in 2002. Its fundamental aim is to support cities to introduce ambitious transport measures and policies towards sustainable urban mobility. The goal of CIVITAS is to achieve a significant shift in the modal split towards sustainable transport, an objective reached through encouraging both innovative technology and policy-based strategies.

In the first phase of the project (2002 to 2006), 19 cities participated in four research and demonstration projects; in CIVITAS II (2005 to 2009), 17 cities participated across a further four projects. The initiative is currently in its third phase, CIVITAS Plus (2008 to 2013), and 25 cities are now working together on five collaborative projects. In total, almost 60 European cities have been co-funded by the European Commission to implement innovative measures in clean urban transport, an investment volume of well over EUR 300 million. By signing a non-binding voluntary agreement known as the CIVITAS Declaration, cities and their citizens benefit from the accumulated know-how and lessons learned of every participant; politicians and technical experts can meet each other once a year through the CIVITAS Forum Conference, in one of the network's cities, for exchanging information and experiences and therefore improve their future policies.

Within CIVITAS, eight thematic categories of measures have been identified as the basic actions of an integrated strategy for sustainable mobility. The eight building blocks are: clean fuels and vehicles, collective passenger transport, demand management strategies, mobility management, safety and security, car-independent lifestyles, urban freight logistics and transport telematics.

The fifth theme concerns sharing experience and knowledge. The Commission will help and support the exchange of information and existing experiences, in particular on model schemes developed through Community programs. Data, statistics and information are necessary for the proper design of policies, it can also help cities with less experience, knowledge and financial resources to capitalize on the practices developed by cities that are more advanced in the area of sustainable urban mobility; in areas such as pedestrian and cyclist safety, for example, an exchange of best practice can help improve the safety of vulnerable road users in urban areas.

Learning from others' experience is also an action to take for developing and implementing a sustainable mobility plan, as suggested in the already cited document by Bührmann, Wefering and Rupprecht (2011), because " It can be extremely valuable to learn from the experience of those who have already implemented measures which you are considering for your local context" also for avoiding "costly mistakes that others may already have learnt from" (p. 78).

First action of this theme is upgrading data and statistics, and the

Commission will launch a study on how to improve data collection for urban transport and mobility. Every policy should have clear and measurable targets, in order to easily evaluate its effectiveness and impact, and the collection of data will help to construct a constant monitoring activity and therefore increase the transparency and accountability of every policy (usually funded with public moneys).

Action seventeenth is about setting up an urban mobility observatory. The urban mobility observatory should have the form of a virtual platform in which it's possible share information, data and statistics, monitor developments and facilitate the exchange of best practices. The platform should include a database with information on the wide range of tested solutions already in place, training and educational material, staff exchange programs and also provide an overview of EU legislation and financial instruments relevant to urban mobility. Something similar already exists and it can be just improved, it's ELTIS, the European Local Transport Information Service, and it's Europe's main portal on urban mobility. It consists of successful examples of urban transport initiatives and strategies in EU, guides, handbooks and on-line tools to support the creation of urban transport systems and also European policy reviews, funding sources and transport statistics.

Action 18 remarks the importance of contributing to international dialogue and information exchange. Since local and regional authorities across the world are confronted with similar mobility challenges (like climate change, facilitating international trade, ensuring social equity, congestion, pollution etc.), the Commission will facilitate dialogue, city-twinning, and information exchange on urban mobility with neighboring regions and global partners, also opening CIVITAS Forum network to cities from the Eastern neighborhood and African regions (Commission of the European Communities, 2009). A good example of a project based on information exchange is the European NICHES+ Project, funded by the European Commission under the Seventh Framework Programme for

R&D, that aims at networking stakeholders that work on innovative urban transport and mobility solutions and transfer their knowledge from a "niche" position to a mainstream urban transport application. The project selected 12 innovative urban transport concepts in four thematic areas: enhancing accessibility, efficient planning and use of infrastructure and interchange, urban traffic management centers and automated and space efficient transport; and successfully integrated them into urban transport policies of six local and regional authorities in Europe (Bührmann, Cré et al., 2012).

The last theme concerns optimizing urban mobility. To create an efficient transport system is fundamental interoperability and interconnection between different transport networks.

This can facilitate modal shift towards more environmentally friendly modes of transport and efficient freight logistics. Affordable and family-friendly public transport solutions are key to encourage citizens to become less car-dependent, in conjunction with the exploration of new forms of mobility, for example in the form of car-sharing, carpooling and bike-sharing.

Every company can influence the travel behavior of their employees, bringing their attention towards sustainable transport options, and public administrations can provide support through financial incentives and parking regulations. The pollution and congestion problems deriving from commuting to work is indeed a serious problem, for example in London, 20% of commuters spend more than two hours a day traveling to and from work, while in Germany 37% spend one hour a day commuting (Transport for London, 2009; Infas institute, 2008). In the USA the situation is not better: a report based on the 2009 American Community Survey (ACS is an ongoing survey conducted annually by the U.S. Census Bureau that captures changes in the socioeconomic, housing, and demographic characteristics of communities across the United States) highlighted that among workers 86.1 % commuted in a car, truck, or van in 2009, and 76.1

percent drove to work alone. The private automobile's dominance represents a long-standing pattern in the USA, in fact the number of workers who commuted by private automobile increased continuously between 1960 and 2009, from about 41 million to about 120 million (McKenzie and Rapino, 2009).

Action 19 is about the urban freight transport. The main target is improving the links between long-distance, inter-urban and urban freight transport, aiming to ensure efficient “last mile” delivery, focusing on how incorporate freight transport in local policies and plans and how to better manage and monitor transport flows. Five urban freight transport policies are presented in the article “Urban Freight Policies and Distribution Channels” by Danielis, Rotaris and Marcucci (2010); these measure are all frequently implemented all across the Europe with the common aim of reducing congestion and pollution deriving by the delivery of goods in urban areas.

The first is the time-access regulation of goods vehicle, which could reduce the perceived impacts of trucks on congestion during certain periods of the day, increase pedestrian safety or reduce the nuisance caused by urban freight transport, especially during nighttime or the early morning hours. Different types of implementation lead to different aim, since some cities prefer to restrict access during the night, others prefer to restrict access during the morning peak and others distribute restrictions all day long.

The second measure is the restriction based on vehicle type. Cities can regulate vehicle access according either to their dimension, weight, loading factor (measured as the ratio of the actual weight of goods carried to the maximum weight that could have been carried on a trip), emission factor or fuel type. The limits imposed on the truck dimension or its weight are aimed at decreasing congestion, road occupancy and the large emissions of air pollutants that characterize large trucks. As in the previous case, there is a high variability of restriction limits even in the same country (for example in Italy). A potential side effect is that more small trucks can have the same or even more negative effects compared to fewer large trucks.

Third measure: loading/unloading policies. With a given number of parking spaces available there exists a competition between passenger and freight parking needs. It is not uncommon that loading/unloading (l/u) areas are used by a car, often illegally, as a solution for missing car parking spaces. City authorities need to determine how many l/u parking lots make available for freight distribution, where position them and control for unauthorized occupations.

The fourth measure are the fiscal policies, that comprise both taxes and subsidies. Taxes could be imposed as congestion charges or area licensing and can be defined accordingly to vehicle type (load factor, size, Euro emission standard), and/or to time window. In Italy, area licensing is quite differentiated among cities and according to fuel type and third-party versus own account transport, and “the rational for such a differentiation is not completely clear and it is probably based more on political compromise than on economic or efficiency improving reasons” (Danielis, Rotaris and Marcucci, 2010, p.135). A negative effect of congestion charges is that must be determined who bears the cost, because it can be passed through the chain to the consumer (or retailer), or the carriers who pay the tax can bear effectively its cost.

Last measure is the introduction of urban transshipment and consolidation centers. Urban consolidation centers include all initiatives that use a building in which the flows from outside the city are consolidated, with the objective to bundle inner-city transportation activities.

The idea on which this initiative is based consists of separating the distribution activities in those inside the city and outside the city. This objective can be achieved by providing facilities in or close to the urban area whereby deliveries (retail, office, residential or construction) can be consolidated for subsequent delivery into the target area in an appropriate smaller vehicle with a high level of load utilization, which results in a minimum number of vehicles entering the city. (Browne M., Woodburn A., Allen J., 2007). Transshipping at the city border makes it possible to benefit from the advantages of large vehicles for long haul transport outside the city without having the disadvantages in the urban area, such as pollution, hindrance and traffic (Van Rooijen T., Quak H., 2009).

The last of the actions suggested by the Commission of European Communities to improve urban mobility is the widespread use of intelligent transport systems (ITS) for urban mobility.

Some possible applications for example are electronic ticketing and payment, traffic management, travel information, access regulation and demand management, and more opportunities are opened up by the European Galileo GNSS system (the global navigation satellite system currently being built by the European Union and European Space Agency). First objective should be the improvement of the interoperability of ticketing and payment systems across services and transport modes, with a focus on major European destinations (airports, rail stations).

Urban sprawl, transport development and extension of infrastructures

In this chapter various topics will be covered, all of them strictly related, starting from land consumption and urban sprawl, two classic issues of the last century. Then I'll present a possible solution to them: the land use planning, highlighting both the positive and negative consequences of the compact city theory.

After that, the focus will shift on the creation of new transport infrastructure, in particular roads, along with its negative effects and a possible solution such as beforehand project evaluation. A document concerning the construction of new roads in response to congestion will be analyzed: "Reclaiming city streets for people: chaos or quality of life?", by the Directorate-General for the Environment of the European Commission (2004), that also introduce the concept of "traffic evaporation", very useful for the reallocation of road space in urban environment.

The document "Environmentally Sustainable Transport, futures, strategies and best practices" by OECD (2000) shed light on an important effect of the continuous increase in road transport: the land consumption. Since during the 20th century the motorized movement of people and goods both increased more than one hundredfold, while the total human population just increased fourfold, now the transport infrastructures, mainly roads, consume about 25–40 per cent of land in urban areas of the OECD (more in North America) and less than 10 per cent in rural areas.

The road network occupies 93 per cent of the total area of land used for transport in the European Union, while rail is responsible for four per cent of land take. Roads are cutting natural and agricultural areas in ever smaller pieces, threatening the existence of wild plants and animals.

The extreme expansion of infrastructure is directly related to urban sprawl. As explained in the OECD report, urban sprawl is the phenomenon whereby urban areas spread at a much higher rate than population growth, and this type of expansion of urban areas (typical of many OECD countries, notably the U.S., Canada, and Australia) is associated with very high levels of fossil fuel use for transport and other purposes, and massive appropriation of what is often prime agricultural land, with further transport implications in relation to food supply.

There are many reasons for the constant increase in the world of the “diffused metropolis”, all of them closely connected to one another. As far as residential location is concerned, the main reasons appear to be the decline in environmental quality of the densely built city center (due to pollution, traffic congestion, degradation of public spaces and reduction of safety), but must be considered also the fact that housing improvement in the city center costs more than new construction outside the city, and the replacement of residential land use in the city center by tertiary activities. If the analysis concerns the economic activities, among the reasons for suburbanization there is a lower development cost for activities in rural areas, the development of out-of-town shopping centers based on the use of the car, the difficulty of access to the city center by car (Camagni, Gibelli and Rigamonti, 2002).

A possible solution is the improvement of land use planning: trying to regulate land use in an efficient and ethical way, satisfying the needs of the community while safeguarding natural resources. Accordingly to Holden (2007), “it is believed that land use planning renders possible more sustainable consumption patterns in general, and sustainable mobility in particular” (p.139), even if there are many criticisms to this vision of planning.

In a short review of possible critiques to urban planning made by Holden (2007), we can find the claim that engine technology and taxes on gasoline and driving are more effective measures for reducing energy consumption, the assertion that socioeconomic and attitudinal characteristics of people are far more important determinants of travel behavior than urban form, and the “self-selection bias”, asserting that travel preferences rather than urban form influence travel behavior (implying that people live in city centers because they prefer to travel less, not that they travel less because they live in city centers). Anyway "there seems to be overwhelming support in the literature for the idea that planning does matter in determining the level of energy consumption in urban areas" (ibid. p.142), and also Stead and Marshall note that "planning policies can influence transport supply and parking as well as the distribution of land uses, and hence provide a way of influencing travel demand and/or modal choice at source" (Stead and Marshall, 2001). Once the hypothesis that land-use planning (and therefore urban form) influences the mobility is accepted, the main question became which urban form will better lead to sustainable mobility.

There are two dominant and opposite theories about sustainable urban form: the compact city and the dispersed city. The main principle in the compact city theory is high-density development, with mixed land use. Mixed-use development is any urban growth in which is unified a combination of residential, commercial, cultural, institutional, or industrial functions, physically and functionally integrated. This implies densely and concentrated housing development, facilitating multifamily housing that are more environmentally friendly than single-family housing, but also low energy consumption for everyday travel, since residences, services and workplaces are all close to each other. Another advantage of compact cities is the opportunity for public transport to play an important role in promoting accessibility: given that transport demand and activities are concentrated and distances are small, public transport can be able to compete whit private vehicles, allowing all segments of society a minimum level of transport. Accessibility means the ease and ability to access basic services, such as education, work, shopping, health and leisure services, using various transport options. Such access is an essential component of economic and social activities and providing it at the lowest possible environmental and economic cost is a key objective of transport policy (European Environment Agency, 2004).

On the other hand, who criticize the compact city suggest a more open type of urban structure, with alternation of buildings, fields and other green areas, in order to avoid one of the main flaw of the compact city: the excessive congestion. Other arguments against the compact city theory are that it does not include green and open space reducing environmental quality, it rejects suburban and semi-rural living and lessens the power for making local decisions. Anyway an international consensus favoring the compact city as a sustainable development approach has dominated the debate so far (Holden, 2007).

It's now clear that “certain urban forms appear to be more sustainable in some respects, for example in reducing travel, or enabling fuel efficient technologies, but detrimental in others, perhaps in harming environmental quality or producing social inequalities” (Williams, Burton and Jenks, 2000).

Anyway, even if land use measures on their own may have a limited impact on current travel patterns, they at least permit public transport improvements to be more effective, and can avoid relocation in response to road pricing. Clifford et al. (2005) make clear that “the principal elements in an effective land use strategy are to focus development in centers and on public transport corridors, to maintain sufficiently high densities to support public transport, walking and cycling, and to reduce the provision of parking space”. If transport investments lead to an increase in land value, a good mechanism for recovering the policy cost can be the land-value taxation.

Another book concerning how urban form influences travel patterns is “Travel by design. The influence of urban form on travel” (Boarnet and Crane, 2001) which also present a review of the recent literature on the topic, coming to the conclusion that “urban design strategies continue to suffer from a lack of knowledge about their travel impacts, the ability of markets to build alternative neighborhood prototypes, and the willingness of local governments to facilitate their development" (p.177) and so "the link between the built environment and the price of travel should be a cornerstone of future research efforts" (p.179).

Anyway the authors give some "rules of thumb" derived by their empirical researches, which can help guide policy: the most important is that the focus of planners should be on how urban designs influence car trip speeds and lengths. Intuitively, urban designs that place non-work destinations closer to residences might both reduce non-work trip distances and slow automobile trip speeds (due to streets congestion). A possible issue is that slower automobile trip speeds and shorter trip distances together can have opposite effect on trip generation rates. Indeed, "automobile trip generation will be reduced in instances where automobile trip speeds are slowed to the point that they offset the tendency of shorter trip distances to induce more car trips" (p.173).

Therefore, if the aim of the built environment is to reduce non-work car trip, the maximum automobile speed should be slowed sufficiently to counteract the effect of any reduction in trip distances, and congestion can become an ally of planners since its increase can provide an incentive for persons to avoid driving. A difficulty remains since "congestion itself is an external cost and policy-makers must balance the extent to which congestion aids plans to reduce driving with the benefits of reducing traffic congestion" (p. 173).

Camagni, Gibelli and Rigamonti (2002) reached the same conclusion as Boarnet and Crane when they stated in "Urban mobility and urban form: the social and environmental costs of different patterns of urban expansion" that "scientific debate is often marred by prejudices and abstract visions; empirical analyses on the environmental and social costs of different typologies of urban development are very rare (and in the case of Italy, practically non-existent)" (p.200). To fill this gap they developed an empirical analysis with the aim of establishing, in the metropolitan area of Milan, whether different patterns of urban expansion could be associated with different social and environmental costs.

They noted how the choice of transport mode can become for the individual the choice between two alternatives: “adopting cooperative behavior, helping to reduce overall congestion by using public transport, and non-cooperative behavior, using the private car in the hope that most others will not do so” (p.202), reminding a sort of prisoner's dilemma which leads to solutions that are individually rational, but collectively inefficient.

With their empirical researches they were also able to demonstrate that “the relative competitiveness of public transport depends significantly on the form of urban development, and in particular on residential density” (p.210). Indeed public transport is strongly affected by the form of urban development and both its efficiency and competitiveness decline as the form of development becomes more dispersed and unstructured. Another interesting finding is the condition which would allow public transport to gain the full market share of trips: when the average trip time with public transport is 15% shorter of that on private transport; when trip times are the same, public transport can expect to achieve a 75% share; if public transport trip times are the double of those on private transport, they can achieve only the 20% of market share (reduced to 10% when they are triple).

Every year more than 3 million cars are added to the car fleet in Europe, and total road traffic kilometers in urban areas will grow by 40% between 1995 and 2030 (Directorate-General for the Environment, 2004). Often building more roads is the most common policy in response to the need for improved accessibility or to reduce congestion. If on one side transport infrastructure investments bring various benefits, mainly in the form of reduced travel times, on the other significant environmental and social costs can be imposed on society with associated externalities, like habitat fragmentation, transport growth stimulated, air emissions and noise.

Every human activity has an impact on their surroundings, and fragmentation creates significant barriers to the movement of animals; its impact is dependent on the nature of the infrastructure, species existing and their habits, the surrounding landscape structures, climatic conditions and other seasonal changes. All the different ecological zones of Europe have their own vulnerabilities, therefore what can create a serious fragmentation in one region may not be so debilitating in another.

Land fragmentation by infrastructure is closely linked to population density and is therefore greatest in western and central Europe: with its mature infrastructure networks and high-density population, the landscape has been strongly fragmented for a long time and many species requiring much space disappeared long ago (European Environment Agency, 2004).

The road network (all types) occupies 93% of the total area of land used for transport in the EU-15[1], and 85% in the EU-10[2]. Between 1990 and 1998 it is estimated that 30.000 ha of land (about 10 ha every day) were used for motorway construction alone in the EU-15; furthermore the roads not only consume by far the largest amount of land for transport in the present, but the situation will worsen in the future if the current trend will not be changed.

The two graphs show the evolution of transport infrastructure length in the EU-15 and EU-10 between 1990 and 2001. The length of motorways increased ceaselessly, in the EU-10 grew by 62% (1.045 km) in those eleven years, while in the EU-15 it grew by 35% (12.606 km). High-speed rail is also growing rapidly in the EU-15, and most of the new Member States still have significantly higher railway densities (in particular when expressed per capita) than the old Member States, but the trend is changing in favor of road. The length of waterways and conventional rail networks is gradually decreasing (European Environment Agency, 2004).

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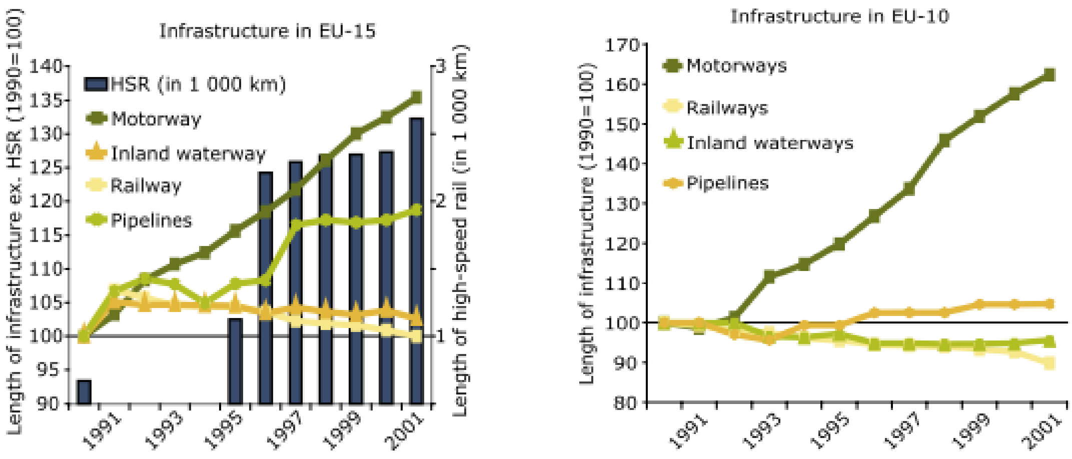
1 Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden and United Kingdom.

2 Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia

Figure 3



Fragmentation is frequently a not reversible process and there is a need for balanced policies concerning infrastructure development. These policies need to take into account alternative location choices as well as all modes of transport. The main policy question is how to enjoy the benefits of high quality transport access while, at the same time, preserving large enough sections of land for biodiversity and social functions: for this reason a priority in creation of new transport projects is the beforehand evaluation, to weigh the costs and benefits related to every plan. Several methods exist, such as strategic and environmental impact assessment (SEA and EIA) or socio-economic cost benefit analysis (SCBA), but there is currently no a uniform or accepted methodology to value adequately many of the negative impacts previously cited: this warps conventional evaluation methods because instead the benefits are largely included and priced.

Also the evaluation of land fragmentation and its impacts and effects on biodiversity, habitats and communities requires further developing (European Environment Agency, 2004).

Another document concerning the construction of new roads in response to congestion is “Reclaiming city streets for people: chaos or quality of life?”, by the Directorate-General for the Environment of the European Commission, in which are presented 8 case studies of European cities that improved the quality of their urban environment mainly reducing road space for private cars.

In some cities where there is enough space it may be possible to promote non-car modes of transport without affecting the amount of road space available to private cars, but the greatest challenge in creating a more attractive place to live is presented in all those European cities where road conditions are already congested, in particular during peak times, and the road capacity cannot be increased but just used more efficiently. Taking road capacity away from private cars is a brave decision for an authority to take, because if a network is already congested, is logically predictable that the removal of capacity can only worsen the situation. Politicians and planning authorities may abandon all the proposals of reallocating road space, if there are prediction of adverse economic impacts and traffic chaos.

In such context the concept of “traffic evaporation” can help planning authorities, supporting this innovative approach. In the document are presented some experiences that demonstrate that traffic problems following the implementation of a scheme are usually not serious as predicted, mainly because, after an adjustment in the initial period, some of the traffic previously found in the vicinity of the target area disappears, due to drivers changing their travel behavior; as a result, the urban environment becomes more livable in many respects.

In a survey commissioned by the European Commission in 1999, when people were asked to identify effective solutions to solve environmental problems linked to traffic in towns, priority was given to improving the quality of public transport, creation of more pedestrian areas and greatly reducing the dominance of car

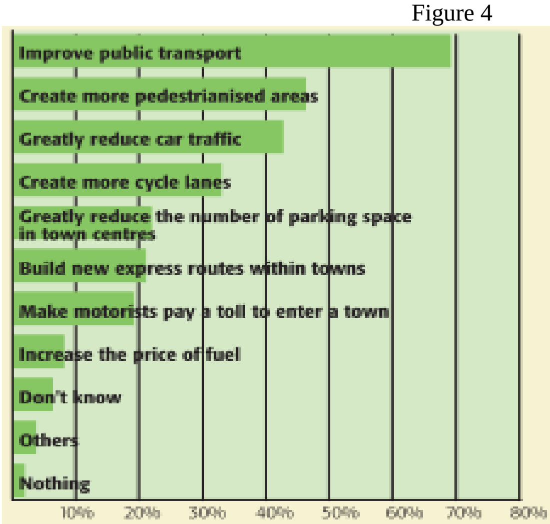


Figure 4

traffic, while build new express routes within towns gained very low score, as highlighted in Figure 4 (European Commission, 1999).

A process related to the construction of new roads is also the “traffic induction cycle”, which shows some possible and inefficient consequences. When a new road is built, in the short and medium term some people will simply use the time savings afforded by the new road to drive further; while in the longer term, people's location decisions can be influenced by the new road (mainly with the choice of where to live in relation to their work). Therefore some people will simply choose to travel further in the same time rather than accept the time-saving offered by the new infrastructure, with no gains in environmental and congestion issues. (Directorate-General for the Environment of the European Commission, 2004).

Case studies presented in the document “Reclaiming city streets for people: chaos or quality of life?” show how, in each city, the reallocation of road space has been one part of an integrated strategy with a number of complementary elements, including improvements to public transport, upgrades to walking and cycling facilities, and renovation of the urban environment.

In the majority of the cases, planners and politicians have encountered opposition on two main issues: firstly that existing congested conditions will be made worse and secondly that retail trade will suffer. In each of the examples a long period of consultation and extensive communications campaigns have been launch, even for many years, to face protests that in some case have been very powerful. At the end of this consultation period, despite opposition, the road space reallocation has gone ahead, and after an initial period of adjustment the predicted traffic chaos did not materialize and moreover a proportion of the traffic disappeared. The scale of the impacts on retailers is more difficult to judge, however in the majority of cases trade has improved due to pedestrianization of the streets that permitted an easier access to shops.

The cited document provides also some guidelines for the implementation of plane concerning reallocation of road space, that are here briefly revised.

Certainly, engaging local politicians and stakeholders (such as residents and retailers) at each stage of the process is essential. Public meetings can reduce opposition in public opinion, and also showing links between the objectives of road space reallocation scheme and national and European sustainable development policy guidelines. In any consultation must be found a balance between flexibility to adapt to any advice or complaint, but not undermine the original scheme.

Then, during the design phase, the situation must be measured and observed rigorously, in order to have a benchmark for comparing the situation after the plan has been implemented. Information like traffic flow, air quality and retail sales statistics may provide vital evidence in demonstrating the success of the project.

Also in this document is stressed the importance of evaluation methods, that may help to win the argument in favor of a scheme in particular when convincing traffic engineers. For enabling interested parties not too much experts in traffic management, could be useful build a scale model of the proposal.

Of course taking away space from car drivers should be counterbalanced with, for example, an upgraded cityscape, better public transport services or improved cycling conditions. After all, road space reallocation is not about making life difficult for car drivers, but about improving the mobility options and quality of urban life for all.

Since retailers are often the group with the most direct concerns, it is essential to build partnerships with local businesses that may be affected by the plan, in order to understand their needs and find ways to minimize any negative impacts on them. For having public support could be also useful collaborate closely with the media, avoiding adverse publicity with sensationalist or negative headlines, that are difficult to counteract. From the beginning all the information should be provided to the media, brief them on all the benefits and the potential problems of the scheme, especially during the early stages of the scheme.

The media could be used also for keeping all sectors of the public informed and develop an effective marketing strategy, with a distinctive brand or image for the plan.

To show the differences of the situation before and after the implementation of the plan it's easy and valuable take some photographs of the interested locations, even for remembering the improvements in the future to win support for other projects.

After the implementation, a lot of communications, police support and the presence of local authority personnel on-site can help to minimize problems due to roads closure and adaption of drivers, but the main effort should be done during the planning operations trying to forecast every possible problem. Finally, it's important to remember that it's impossible satisfy the needs of all parties involved, but after the initial period usually acceptance increase by the majority of parties.

Different scenarios for 2030

In the last chapter of his book, Holden (2007) tries to respond to a key question: how can the EU achieve sustainable mobility? After having analyzed all its characteristics and issues, is there a holistic approach that can effectively help the EU to accomplish it by 2030?

In its work Holden establishes two goals that indicate if the sustainable mobility is reached or not, the first is in accordance with the Brundtland Report's low-energy scenario, and impose a reduction in energy consumption for passenger transport to 50 per cent or less of the 1990 level, so not exceeding 8 kWh daily; the second is the available travel distance by public transport that in 2030 have to be at least 11 km per capita daily.

Holden constructed seven scenarios concerning different approaches on how reach sustainable mobility, and then he calculated yearly per capita energy consumption for passenger transport and yearly travel distance by public transport for each different scenario, comparing the outcomes to the already cited goals, to control whether a particular scenario lead the EU into the SMA (he uses EU-15 data)

Four scenarios employ a bottom-up approach, this means that improvements in specific energy consumption, changes in occupancy rates and annual transport growth rates for each mode are used as assumptions, and the model calculates the results to be compared with sustainable mobility goals (2030 per capita energy consumption and per capita travel distance by public transport). The other three employ a top-down approach, so these scenarios per definition comply with the sustainable mobility requirements, and the models finds various combinations of the levels of specific energy consumption, occupancy rates and transport growth rates for all means of transport that would fulfill the sustainable mobility goals.

The methodology through which Holden measures the yearly per capita energy consumption for passenger transport (E_{pt}) is $E_{PT} = \sum_{i=1}^{n} \frac{d_i}{o_i} * s_i$ where n is the number of modes, d_i the yearly per capita travel distance by mode i, o_i the average occupancy rate for mode i and s_i the average specific energy consumption for mode i.

The first four scenarios (bottom-up approach) are:

I. B.A.U. (Business as usual): this scenario is used as a benchmark because it shows the effects of the actual pattern if nothing alters it. Therefore growth in travel distance for all modes follows the same pattern as 1990-2000 as much as the specific energy consumption for all means of transport declines slowly, in line with the reductions achieved in the same period;

II. EFF (Efficiency): in this scenario strong measure are taken to increase technological efficiency for all means of transport, while growth in travel distances for all modes is the same as in the BAU scenario;

III. ALT (alteration): this scenario shows the effects of very strong measures oriented to alter present transport patterns towards greatly increased use of public transport, but growth in total travel distances and reductions in specific energy consumption for all means of transport follow the BAU scenario. The effect would be that 2030 average travel distance by public transport in the EU-15 would be three times greater than what Austria has today (at the moment the highest in the EU15);

IV. RED (reduction): in this scenario strong measures are applied to stop the growth in passenger transport by car and plane, while total travel distances by public transport and specific energy consumption for all means of transport follow the BAU scenario.

The last three scenarios (top-down approach) are:

I. SM1 (sustainable mobility 1): occupancy rates for all means of transport are assumed to increase by 10%, while specific energy consumption for all means of transport is reduced of the same amount of the BAU scenario;

II. SM2: occupancy rates for all means of transport increase by 10% also in this scenario, and in addition specific energy consumption for all means of transport is reduced at a level between BAU and EFF scenario.

III. SM3: occupancy rates for all means of transport still increase by 10% and specific energy consumption for all means of transport is reduced as in the EFF scenario.

The scenario analysis shows that BAU will bring the EU15 far away from the goals of sustainability, because rather than halving per capita energy consumption for passenger transport, BAU leads to a 53% increase, and it does not achieve the goal of public transport too. It's remarkable that, at present transport volume growth rates, it would take about an 85% reduction in the specific energy consumption of cars and planes to become compatible with sustainable mobility's energy goal.

Moreover also the three main approaches are not able to transform the EU-15 into a sustainable mobility area.

The EFF scenario simply stabilizes per capita energy consumption at 2002 levels, and it does not meet sustainable mobility's public transport goal; the ALT scenario ensures obviously that the public transport goal is met, but allows that per capita energy consumption increase about 25 per cent. The RED scenario will reduce per capita energy consumption by 39 per cent, not enough to comply with sustainable mobility's energy goal.

The last three combined approach meet the sustainable mobility goals for definition, but in different ways. Anyway all the three scenarios demand at least a 2.5% annual growth in travel distance by public transport to meet the related goal.

The SM1 scenario demands a reduction of 2030 total travel distance whit respect to the 2002 level; moreover, because travel by public transport increases, this reduction must be applied to travel distances by cars and

planes.
SM2 scenario demands a stabilization of 2030 travel distances by car and plane at the 2002 level but allows for a small increase in the total travel distance, only using public transport.
Finally, the SM3 scenario allows for a small increase in total travel distance, also by car and plane, compared to the 2002 level, but anyway it remains far below than that one permitted in the BAU scenario.
From this analysis we can deduce that there is a reciprocal relation between the roles of technology, public transport, green attitudes and land-use planning and their influence on travel behavior
For example the scenario that allows for an increase in yearly travel distance (SM3) is probably more attractive than the one that demands its reduction (SM1), but it implies also a massive reduction in vehicles' specific energy consumption with respect to the actual level, and it can be achieved not only with improvements in engine technology, but also with a necessary reduction in vehicles' size and speed. People must have willingness to buy smaller, lighter, and less powerful cars; at the same time lower speed limits should be considered, since cars consume more at high speed. Also improving the speed of public transport can be problematic because it can counterbalance the gains in energy consumption from private cars, but on the other hand it could increase the use of public transport and therefore the mobility for low-mobility groups.
Public transports have other roles in changing travel behavior, for example they can encourage mode switching away from travel by car and plane, with benefit to local pollution and congestion.
Green attitudes has a limited role in changing travel behavior, but is not useless at all since green people are more likely to accept or even demand changes in technology, land use planning and public transport.
Land-use planning contains significant potential to change travel behavior, since certain urban forms make sustainable travel behavior more possible than others. A large and growing literature suggests that decentralized

concentration of cities and towns and poly-centric development within large cities are the urban forms that best exploit land-use planning's potential to change travel behavior

Holden (2007) continues asking what could be the role of economics in promoting sustainable mobility. Clearly economic growth is not one of sustainable mobility‘s goals, but it could be a useful tool because economic measures can help to achieve sustainable mobility: for example with differentiated taxation (to promote clean vehicles), carbon tax (to fight global warming), subsidies (to encourage public transport modes) and congestion fees. The main issue is that such economic measures might affect everyday travel and leisure-time travel differently.

According to Holden (2007), the transformation of attitudes and values must precede regulation, even if it has no direct and massive effect, because even in cases where regulatory measures have been implemented, there will always be some degree of freedom left to the individual citizens, and the outcome will depend on their choices.

Data collection for a practical comparison

In an attempt to compare some different approaches to urban mobility, I choose eight European cities (Rome, Stuttgart, Barcelona, Berlin, Amsterdam, London, Paris and Madrid) and measured the average trip time between three main attractors within each city, with private car and public transport. The trip time has been divided into “theoretical” and “effective”, whit the latter that takes into consideration the traffic situation. The collection of data is relative to the morning peak time (7.00 to 9.00) in the month of July 2013, and the traffic information were acquired from Google Maps; if there were some differences between the outward route and the return, I used the average of the two values for: the kilometers, the theoretical trip time for private car and the trip time for public transport.

The three attractors are of the same nature for all the cities: an airport, a main railway station and a tourist attraction. I chose these three attractors because they are presumably the places most frequented by tourists and commuters, and the connection between them can give a good sample of the urban mobility of a city. In some case I did not choose the most important railway station or tourist attraction because traffic information weren't available for those particular attractors (for example the Sants Estaciò in Barcelona).

Four of these cities have taken part in one or more projects of the CIVITAS network (Rome, Stuttgart, Barcelona and Berlin).

For many routes there were available at least two different kind of public transport, but I chose the fastest since this comparison is based especially on the speed; must be noted that sometimes the fastest public transport was also the most expensive, but the slower public transport, even if creating lower income for the public authority, must not be removed (or maintained at a low-quality standard) because it's used in particular by the poorest and the old people, and its disappearance could create an urban mobility system that is social unsustainable.

In Rome and London it was not possible use only the car to reach the tourist attraction since there is a restrictions on the accessibility of the city centre, so I presumed a trip made by car until it was possible, and then continued on foot.

I choose the car model most sold in Europe in 2012 as a benchmark in the calculation of the consumptions: a Volkswagen Golf VI, with a 1.4 TSI engine that runs on unleaded gasoline, and 122 Hp.

The cost of the trip made by car is calculated partially from www.aci.it, the website of Automobile Club d’Italia (a non-economic, self-financed statutory corporation of the Republic of Italy), for the part concerning the tires consumption and maintenance. In detail, the life span of tires is estimated in 35000 kilometers, but it's clearly an average value since it can be considerably less when they are used on uneven roads. Both routine maintenance and emergency maintenance have been considered, including periodical services at intervals specified by the vehicle manufacturer, all the operations that usually are done for keeping the car efficient (checking or replacing the clutch, brake system, shock absorbers etc.), as well as some expenses to fix damages to the body of the car, quite frequent especially in urban environment (ACI, 2012). In conclusion concerning tires and maintenance and regarding the model of car selected, the average cost, always susceptible of significant variations, is 0,084255€ per km.

For the fuel I used the average price of each state found in the Fuel Price Report of June 2013 by the Automobile Association, and the fuel consumption declared by the Volkswagen: 6,2 liters per 100 km (combined use between urban and extra urban area).

Thus, I considered only the expenses proportional to the distances effectively covered. This detail must be not underestimated since there are huge costs related only to the ownership of a car, and not to its usage. For example the insurance for the vehicle: in Europe the average motor third-party liability premium amounted to 230€ in 2008, and it reaches 439€

including also own damage premiums. This average shows huge differences at national level, with Italy being the biggest motor insurance market (CEA Statistics, 2010).

The average speed by public transport is calculated using the distance travelled by car (by car and on foot for London and Rome). In the average trip time by public transport is included also the time necessary to reach every station/stop on foot. Average real trip times are rounded to the nearest integer, while prices and average speeds are rounded to the second decimal place. The average walking speed used by Google Maps is around 4,8 km/h, a quite slow pace.

LONDON
1 = King's cross station
2 = Big Ben
3 = Gatwick airport
A = Train + Metro
B = Metro

	1 -> 2	2 -> 1	1 -> 3	3 -> 1	2 -> 3	3 -> 2
Distance by car (km)			55,4	55,4	41,7	41,7
Theoretic trip time by car (min.)			72	72	50	50
Average real trip time by car (min.)			95	98	62	66
Average theoretic speed by car (km/h)			46,17	46,17	50,04	50,04
Average real speed by car (km/h)			34,99	33,92	40,35	37,91
Expense by car (€)*			10,09	10,09	7,6	7,6
Additional distance on foot (km)	3,8	3,8			2	2
Average trip time on foot (min.)	50	50			26	26
Total trip time by car + on foot (min.)					88	92
Total average speed by car + on foot (km/h)	4,56	4,56			28,43	27,2
Average trip time by public transport A (min.)			50	50	51	51
Average trip time by public transport B (min.)	25	25				
Average speed by public transport A (km/h)			66,48	66,48	49,06	49,06
Average speed by public transport B (km/h)	9,12	9,12				
Expense by public transport A (€)*			25,82	25,82	25,82	25,82
Expense by public transport B (€)*	2,46	2,46				

Source for the information about public transport (trip time and ticket price) are from www.tfl.gov.uk, website of the local government body responsible for most aspects of the transport system in Greater London.
Note: all the Metro ticket prices are related to the use of an Oyster Card (free), otherwise should be increased by 2,82€ more.
Average fuel cost per liter: 1,58€*
* Exchange rate of 0,851934£ = 1 €, average value of June 2013

BERLIN
1 = Berlin Hauptbahnhof, central station
2 = East Side gallery
3 = Tegel airport
A = Metro
B = Train + Bus

	1 -> 2	**2 -> 1**	**1 -> 3**	**3 -> 1**	**2 -> 3**	**3 -> 2**
Distance by car (km)	6,4	6,4	8,3	8,3	14,8	14,8
Theoretic trip time by car (min.)	15	15	17	17	30	30
Average real trip time by car (min.)	21	22	22	21	38	36
Average theoretic speed by car (km/h)	25,6	25,6	29,29	29,29	29,6	29,6
Average real speed by car (km/h)	18,29	17,45	22,64	23,71	23,37	24,67
Expense by car (€)	1,15	1,15	1,5	1,5	2,67	2,67
Average trip time by public transport A (min.)	29	29				
Average trip time by public transport B (min.)			19	19	59	59
Average speed by public transport A (km/h)	13,24	13,24				
Average speed by public transport B (km/h)			25,89	25,89	15,05	15,05
Expense by public transport A (€)	2,4	2,4				
Expense by public transport B (€)			2,4	2,4	2,4	2,4

Source for the information about public transport (trip time and ticket price) are from www.bvg.de, website of the main public transport company of Berlin.
Average fuel cost per liter: 1,55€

AMSTERDAM
1 = Amsterdam Centraal station
2 = Van Gogh museum
3 = Schiphol airport
A = Tram
B = Train
C = Tram + Train

	1 -> 2	2 -> 1	1 -> 3	3 -> 1	2 -> 3	3 -> 2
Distance by car (km)	5,8	5,8	19,8	19,8	14,6	14,6
Theoretic trip time by car (min.)	14	14	22	22	16	16
Average real trip time by car (min.)	20	18	30	26	20	20
Average theoretic speed by car (km/h)	24,86	24,86	54	54	54,75	54,75
Average real speed by car (km/h)	17,4	19,33	39,6	45,69	43,8	43,8
Expense by car (€)	1,14	1,14	3,88	3,88	2,86	2,86
Average trip time by public transport A (min.)	19	19				
Average trip time by public transport b (min.)			18	18		
Average trip time by public transport C (min.)					23	23
Average speed by public transport A (km/h)	17,05	17,05				
Average speed by public transport B (km/h)			66	66		
Average speed by public transport C (km/h)					38,09	38,09
Expense by public transport A (€)	1,3	1,3				
Expense by public transport B (€)			3,9	3,9		
Expense by public transport C (€)					3,75	3,75

Note: all the Metro ticket prices are related to the use of an OV-chipcard (it costs 7,50€ and it is valid for 5 years), otherwise should be increased by 1,40€ at least.
Source for the information about public transport (trip time and ticket price) are from http://9292.nl/en
Average fuel cost per liter: 1,80€

STUTTGART
1 = Stuttgart Hauptbahnhof, central station
2 = Mercedes – Benz museum
3 = Stuttgart airport
A = Light Metro + Bus
B = Light Metro

	1 -> 2	**2 -> 1**	**1 -> 3**	**3 -> 1**	**2 -> 3**	**3 -> 2**
Distance by car (km)	6	6	14	14	18,5	18,5
Theoretic trip time by car (min.)	12	12	16	16	24	24
Average real trip time by car (min.)	12	21	19	24	32	30
Average theoretic speed by car (km/h)	30	30	52,5	52,5	46,25	46,25
Average real speed by car (km/h)	30	17,14	44,21	35	34,69	37
Expense by car (€)	1,08	1,08	2,52	2,52	3,34	3,34
Average trip time by public transport A (min.)	16	16				
Average trip time by public transport B (min.)			27	27	42	42
Average speed by public transport A (km/h)	22,5	22,5				
Average speed by public transport B (km/h)			31,11	31,11	26,43	26,43
Expense by public transport A (€)	2,6	2,6				
Expense by public transport B (€)			3,6	3,6	3,6	3,6

Source for the information about public transport (trip time and ticket price) are from www.vvs.de, website of the regional transport cooperative that coordinates all transport operators in the metropolitan area of Stuttgart.
Average fuel cost per liter: 1,55€

ROME
1 = Roma Termini, central station
2 = Trevi fountain
3 = Fiumicino airport
A = Bus
B = Train
C = Train + Metro

	1 -> 2	**2 -> 1**	**1 -> 3**	**3 -> 1**	**2 -> 3**	**3 -> 2**
Distance by car (km)	1	1	30,8	30,8	28,7	28,7
Theoretic trip time by car (min.)	3	3	31	31	26	26
Average real trip time by car (min.)	3	3	36	42	29	32
Average theoretic speed by car (km/h)	20	20	59,61	59,61	66,23	66,23
Average real speed by car (km/h)	20	20	51,33	44	59,38	53,81
Expense by car (€)	0,19	0,19	5,94	5,94	5,53	5,53
Additional distance on foot (km)	1,3	1,3			1,6	1,6
Average trip time on foot (min.)	16	16			20	20
Total trip time by car + on foot (min.)	19	19			49	52
Total average speed by car + on foot (km/h)	7,26	7,26			37,1	34,96
Average trip time by public transport A (min.)	16	16				
Average trip time by public transport B (min.)			32	32		
Average trip time by public transport C (min.)					51	51
Average speed by public transport A (km/h)	8,63	8,63				
Average speed by public transport B (km/h)			57,75	57,75		
Average speed by public transport C (km/h)					35,18	36,12
Expense by public transport A (€)	1,5	1,5				
Expense by public transport B (€)			14	14		
Expense by public transport C (€)					15,5	15,5

Source for the information about public transport (trip time and ticket price) are from www.atac.roma.it, website of the public transport agency of Rome. Average fuel cost per liter: 1,75€

BARCELONA
1= Estaciò de França, railway station
2 = Camp Nou stadium
3 = El Prat airport
A = Bus + Metro
B = Bus

	1 -> 2	2 -> 1	1 -> 3	3 -> 1	2 -> 3	3 -> 2
Distance by car (km)	6,7	6,7	15,7	15,7	13,3	13,3
Theoretic trip time by car (min.)	13	13	16	16	14	14
Average real trip time by car (min.)	18	19	21	19	17	15
Average theoretic speed by car (km/h)	30,92	30,92	58,88	58,88	57	57
Average real speed by car (km/h)	22,33	21,16	44,86	49,58	46,94	53,2
Expense by car (€)	1,15	1,15	2,71	2,71	2,29	2,29
Average trip time by public transport A (min.)	36	36				
Average trip time by public transport B (min.)			55	55	43	43
Average speed by public transport A (km/h)	11,17	11,17				
Average speed by public transport B (km/h)			17,13	17,13	18,56	18,56
Expense by public transport A (€)	4	4				
Expense by public transport B (€)			7,9	7,9	7,9	7,9

Source for the information about public transport (trip time and ticket price) are from www.tmb.cat, website of the main public transit operator in Barcelona.
Average fuel cost per liter: 1,42€

MADRID
1 = Puerta de Atocha central station
2 = Palacio Real
3 = Madrid – Barajas airport
A = Metro
B = Train

	1 -> 2	2 -> 1	1 -> 3	3 -> 1	2 -> 3	3 -> 2
Distance by car (km)	3,6	3,6	16,2	16,2	19,5	19,5
Theoretic trip time by car (min.)	8	8	15	15	18	18
Average real trip time by car (min.)	10	13	20	19	25	24
Average theoretic speed by car (km/h)	27	27	64,8	64,8	65	65
Average real speed by car (km/h)	21,6	16,62	48,6	51,16	46,8	48,75
Expense by car (€)	0,62	0,62	2,79	2,79	3,36	3,36
Average trip time by public transport A (min.)	17	17			43	43
Average trip time by public transport B (min.)			18	18		
Average speed by public transport A (km/h)	12,71	12,71			27,21	27,21
Average speed by public transport B (km/h)			54	54		
Expense by public transport A (€)	1,5	1,5			5	5
Expense by public transport B (€)			2,5	2,5		

Note: the train connecting the airport is only from and to Terminal 4
Source for the information about public transport (trip time and ticket price) are from www.ctm-madrid.es, website of the public transport agency of the Community of Madrid. Average fuel cost per liter: 1,42€

PARIS
1 = Gare d'Austerlitz, railway station
2 = Tour Eiffel
3 = Charles de Gaulle airport
A = Train

	1 -> 2	**2 -> 1**	**1 -> 3**	**3 -> 1**	**2 -> 3**	**3 -> 2**
Distance by car (km)	7,1	7,1	31,2	31,2	31,9	31,9
Theoretic trip time by car (min.)	19	19	29	29	33	33
Average real trip time by car (min.)	25	23	39	60	43	57
Average theoretic speed by car (km/h)	22,42	22,42	64,55	64,55	58	58
Average real speed by car (km/h)	17,04	18,52	48	31,2	44,51	33,58
Expense by car (€)	1,27	1,27	5,59	5,59	5,71	5,71
Average trip time by public transport A (min.)	29	29	50	50	69	69
Average speed by public transport A (km/h)	14,69	14,69	37,44	37,44	27,74	27,74
Expense by public transport A (€)	1,7	1,7	9,5	9,5	9,5	9,5

Source for the information about public transport (trip time and ticket price) are from www.ratp.fr, website of the state-owned operator responsible for most of the public transport in Paris.
Average fuel cost per liter: 1,53€

Conclusion

This research is based on a quite small amount of data, concerning the streets involved and the time interval, so its results should be just indications about the urban mobility of a city, and not a definitive evaluation of its quality.

The city in which the public transport is faster, compared to the private car, is London; the worst is Barcelona, but is dividing the cities between their previous involvement in a CIVITAS project that the most interesting results can appear.

Regarding the non CIVITAS cities, the average time difference between trip on public transport and with private car is 3,8 min in favor of the first. Were considered also the route made by walking because of the Low Emission Zone where cars are not admitted (or with strong limitations), but even using a bike instead of walking the public transport will result in being faster on average (1,4 min).

Otherwise, for CIVITAS cities, the average time difference is 9,4 min in favor of the private car. The option of calculating a trip using the bike is still not available for Rome on Google Maps, but assuming an average speed of 14km/h the average time difference between public transport and private increase to 11,3 min.

Of course, since it's an average, there are huge differences between cities, even in the same group (for example in London the public transport are faster than private car for all the routes, while in Paris it happens just in one).

Nearly all the public transport considered, run on rails; this is probably due to the traffic of the urban roads that makes essential the usage of vehicles that don't increase (nor they are affected by) the congestion.

Focusing on the economic side, on average the public transport cost 2,68 € more than private car (not considering the routes travelled also on foot). This simple element should not let think that the car is definitively cheaper than public transport, for many reasons. Firstly, as already said, we considered only the expenses proportional to the kilometers effectively travelled, and not all the cost related only to the ownership of a car; secondly, travelling by car involves many more risks than travelling with public transport, and even if quantifying them is very hard, they should be included in the direct expenses.

Moreover, the price of public transport was calculated using the fare for a single ticket, but with monthly or annual ticket the price for a single trip is usually substantially less; eventually, I considered the combined fuel consumption for calculating the fuel expense, but many routes were only in urban area so the final cost could be significantly higher.

Looking at the total average speed by car, it's 35,41 km/h, and the highest value is slightly less than 60 km/h. These low value of the speed are probably caused by the traffic and also by the urban regulation in an attempt to avoid car crashes; driving so slowly (and especially in urban areas, with many stops) can increase notably the stress of the driver, moreover it makes evident how useless can be using cars with big and powerful engine (and related high consume) for the everyday commuting.

Looking at the data, a simple conclusion could be that the CIVITAS project is inefficient, since the public transport is faster on average in the city that doesn’t join the project. This is pretty hasty since the role of the CIVITAS forum about exchanging information and experiences between different towns around Europe is clearly precious, what the results should suggest is instead that a good organization of the urban mobility is possible in every contest, as long as prepared manager are in charge and informed citizens are aware of the importance of a sustainable urban mobility system.

According to Banister (2007) the purpose of sustainable mobility is not to prohibit the use of the car, is to design cities of such quality and at a suitable scale that people would not need to have a car.

In this thesis, starting from the three extra prima characteristics of sustainable mobility derived by Holden (2007), I presented the three approaches explored by the literature that can lead to sustainable mobility: the efficiency approach, suggesting that the environmental problems caused by transport can be solved just by developing more efficient technology; the alteration approach, imposing the change of present transport patterns dominated by private cars and planes and replacing them with an efficient public transport system, and the reduction approach, sustaining that the present transport volume must urgently be decreased. All of these approaches have a reasonable justification, but only a mixed approach that combines all of them could reach a sustainable mobility system.

The sustainable mobility in cities has some particular characteristics due to the social and environmental complexity of such an area. After an analysis of the document "Action Plan on urban mobility" by the Commission of European Communities (2009) is possible to conclude that some actions are essential to create an urban sustainable mobility: promoting integrated policies, developing sustainable urban mobility plans, sharing experience and knowledge between policy makers, providing to citizens information and education on sustainable mobility, the internalization of external costs with market-based incentives and the improvement of interoperability and interconnection between different transport networks.

About the land consumption and urban sprawl, the planners should focus on how urban designs influences the relative competitiveness of public transport in relation to private car, and operate through the land use planning; until now the compact city is still the dominating approach.

Planning authorities can also find useful support from the theory of "traffic evaporation", demonstrating that traffic problems following the implementation of a scheme are usually not serious as predicted, mainly because drivers change their travel behavior.

In the end, the choice of transport mode can become for the individual the choice between a cooperative behavior, using public transport, and a non-cooperative behavior, using the private car in the hope that most others will not do so, reminding a sort of prisoner's dilemma which leads to solutions that are individually rational, but collectively inefficient (Camagni, Gibelli and Rigamonti, 2002).

Therefore, any possible approach is doomed to fail if it doesn't consider the involvement of the citizens, for example with push and pull measures, since changes in sustainable mobility cannot and should not take place unless and until they are accepted or demanded by a large majority of people.

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